Variation in suckering capacity among and within lateral roots of an aspen clone

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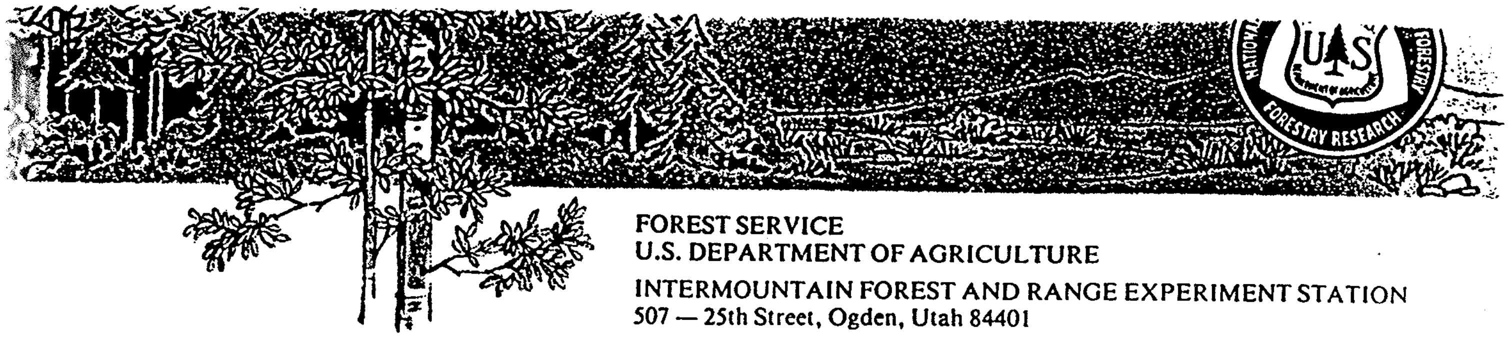

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VARIATION IN SUCKERING CAPACITY AMONG AND WITHIN LATERAL ROOTS OF AN ASPEN CLONE

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ABSTRACT

*Excised roots were used to determine variation in suckering capacity among and within lateral roots of an aspen (*Populus tremuloides *Michx.) clone. Differences among lateral roots were significant. Within segments of a lateral root sucker production showed a high degree of polarity, increasing from the distal to proximal ends. There was no evidence of a gradient in suckering capacity in a segmented root; i.e., distal segments were not significantly different from proximal ones. This indicated that aging was not a factor regulating suckering within lateral roots. Sucker production was not affected by root length.*

KEYWORDS: *Populus tremuloides*, aspen, root suckers, adventitious shoots, polarity.

Many investigators have found large interclonal differences in the relative capacity of aspen (*Populus tremuloides* Michx.) to produce root suckers (Farmer 1962; Maini 1967; Schier 1974; Steneker 1972; Tew 1970; Zufa 1971). However, only Steneker (1972) has studied intraclonal variation in sucker production. When he propagated suckers from root cuttings collected from various parts of a clone, he found significant differences in numbers of suckers produced by the ramets. He also observed a large variation in numbers of suckers produced on cuttings from the same ramet and from the same lateral root.

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My objective was to examine within-clone variation in sucker production to determine (1) if there are significant differences between lateral roots in their ability to produce root suckers, and (2) if there are gradients in sucker production along lateral roots. Sucker production along a lateral root is strongly influenced by polarity (Maini 1967; Steneker and Walters 1971); that is, a larger number of suckers arise on the proximal (end toward stem) than on the distal (end toward root apex) halves of root segments. This gradient is believed to be caused by the polar movement of endogenous growth regulators. However, age-related changes may also cause polarity in roots, as they do in stems. An aging gradient may exist in roots because the first-initiated, proximal end, and chronologically oldest part of a root may be morphologically and physiologically different from its more recently formed distal end. Generally, upper portions of stems are difficult to root, while the lower portions retain the capacity to initiate roots (Heuser 1976). In a similar manner, cuttings from sections of lateral roots near the stem may produce more suckers than cuttings from sections near the root apex.

METHODS

In the summer of 1975, roots were excavated from an area of approximately 0.1 ha within a single aspen clone in the Wasatch Mountains on the Cache National Forest east of Logan, Utah. Single root sections of varying lengths and about 1 to 2 cm in diameter were excised from 27 different lateral roots. Portions of the root sections free of defects (cankers, scars, decay, etc.) were cut into 10 cm segments and washed free of soil. The proximal ends of the segments were marked and their sequence within the lateral root recorded. The segments were randomly distributed among six trays (6 by 26 by 54 cm) in which they were planted to an average depth of 1-1/2 cm in moistened vermiculite. The trays were placed in a greenhouse where the diurnal air temperature varied between 15° and 25° C, and were watered lightly each day. After 6 weeks, the cuttings were removed from the trays and the number of suckers exceeding 5 mm in length on the proximal and distal half of each root segment recorded. The height of the tallest sucker on each segment was measured.

In the summer of 1976, a second root collection was from a different area within the same aspen clone. This time single root sections 50 cm in length and 1 to 2 cm in diameter, and free of defects, were severed from 60 different lateral roots. These were randomly divided into three groups of 20 sections each and each group given one of the following treatments: (1) uncut (1 × 50 cm); (2) cut into two 25-cm segments (2 by 25 cm); and (3) cut into five 10-cm segments (5 × 10 cm). Two sections (proximal ends marked) from each treatment were planted in each of 10 trays. The segments from cut sections were arranged in the sequence in which they were cut. Root sections were cultivated by the same procedures as before. Six weeks after planting the number and dry weight of suckers exceeding 5 mm in height were determined.

Differences in sucker production caused by either treatment or origin were tested by analysis of variance. Significance of differences between ranked means was determined by Keuls' method (Snedecor 1956). A square root transformation was applied to sucker numbers prior to analysis.

RESULTS

Long Root Sections

The length of the lateral root sections excavated ranged from 51 to 412 cm (mean, 182 cm). Diameters of the defect-free root segments (10 cm), cut from the root sections, ranged from 8 to 24 mm (mean, 16.2 mm). There was not much taper within the long rope-like lateral roots. The mean difference in diameter between the largest and smallest segments within a lateral root was only 4.4 mm.

Table 1.--*Variation among lateral roots within an aspen clone in the mean number of suckers per segment (10 cm) and mean height of tallest suckers per segment*

Lateral root	Suckers per segment	Height of tallest sucker	Lateral root	Suckers per segment	Height of tallest sucker
		mm			*mm*
1	6.3	38	15	6.1	42
2	3.7	48	16	4.8	37
3	11.6	51	17	8.3	42
4	8.6	41	18	11.6	51
5	7.8	45	19	0.8	17
6	4.0	35	20	9.6	45
7	11.2	41	21	0.6	12
8	13.0	42	22	7.8	38
9	10.2	30	23	10.7	51
10	17.2	40	24	3.4	48
11	15.9	49	25	12.3	35
12	4.9	42	26	6.8	49
13	5.2	43	27	22.7	44
14	4.1	37			
			MEAN	8.56	42.0

The difference among lateral roots in both number and height of suckers (table 1) was highly significant (1 percent level). Suckering was not related to root diameter. A "t" test for paired replicates showed that the proximal half of root segments produced significantly more suckers than the distal halves. Sixty-four percent of all suckers arose from the proximal ends and only 36 percent from the distal ends. There was no evidence of a gradient in suckering capacity along the lengths of lateral roots. Mean number of suckers produced from segments in the proximal and distal halves of root sections were: proximal, 8.36; distal, 8.75. One would expect less variation in suckering capacity between adjacent segments than between distant segments, but this was not found.

Effect of Root Length

Effect of root length on number and dry weight of suckers produced was as follows:

Treatment	*Suckers per section*	*Dry weight per sucker*
		(mg)
1 × 50 cm	51.0	14.4
2 × 25 cm	55.9	12.9
5 × 10 cm	39.7	13.9

Cutting 50-cm lateral root sections into segments (10 or 25 cm) did not significantly affect number or dry weight of suckers produced by the sections. Within each of the three treatments (1 × 50 cm, 2 × 25 cm, or 5 × 10 cm), differences among lateral

Table 2.--*Distribution of suckers along 50-cm sections of cut and uncut aspen roots (proximal end at 0, distal end at 50 cm)*

Sample condition	2 × 25 cm			5 × 10 cm					
	0	25	50	0	10	20	30	40	50
	Percent								
Uncut		74.8	25.2		33.5[1]	29.8	19.8	12.2	4.7
Cut		53.2	46.8		21.8	19.5	18.5	18.8	21.4

[1]Underlined percentages are not significantly different from each other.

root sections were highly significant (1 percent level). Sucker numbers did not differ significantly between proximal and distal root segments (table 2). However, within uncut sections there was a distinct gradient in suckering capacity; the number of suckers increased along the root from the distal to the proximal end.

DISCUSSION

Steneker and Walters (1971) also found that length of root cuttings usually did not significantly affect sucker production. However, they found that cutting 36-inch (91.4-cm) root sections into 6-inch (15.2-cm) segments significantly reduced mean sucker heights. They also found more suckers on the proximal three segments than on the distal three segments of cut 36-inch root sections, although polarity was not as evident as in uncut roots.

The polarity of sucker formation on excised aspen roots appears to be caused by physiological factors unrelated to aging. If aging had affected suckering, then gradients in suckering capacity would have occurred along segmented lateral roots. Polarity in roots is usually attributed to the transport of auxin toward root tips (Batra and others 1975; Robinson and Schwabe 1977). Auxin, which suppresses suckering in roots of intact plants, breaks down after the roots are excised (Eliasson 1971; Schier 1973c, 1975). Suckers are then able to develop. Polar movement of the residual auxin in segments probably causes higher concentrations in the distal than in the proximal halves, so the distal halves produce fewer suckers. Cytokinins, which stimulate shoot formation, may also influence the polarity shown in sucker development because these hormones move in a proximal direction (El-Saidi 1971; Wareing and Phillips 1970).

Most suckers that arise on aspen roots appear to develop from suppressed shoot primordia (Schier 1973b). Therefore, variation in the capacity of lateral roots to sucker is probably caused primarily by differences in numbers of primordia. Some roots may have many more primordia than others because they are exposed to injuries that stimulate primordia formation.

Generally, roots vary in sensitivity to stimuli that initiate primordia because of differences in hormone levels and ratios, water content, and concentration of nutrients. Two factors that may affect the physiological condition of lateral roots are microclimate and position in the clonal root system. Temperature, an important microclimatic variable, varies with soil depth and exposure to radiation. The position of a lateral root in the root system will determine its location with respect to ramets of various ages and vigor. This will determine the quantity of carbohydrates and auxins and other growth translocated to the root. Some clones have roots with few primordia; a major portion of the suckers are initiated after excision (Schier 1973a). Root cuttings from these clones are probably physiologically preconditioned for sucker development by the factors mentioned. Early growth of suckers may vary with concentration of carbohydrate reserves (Schier and Zasada 1973).

Any sampling method used to estimate suckering capacity of aspen clones must take into consideration the large within-clone variation in sucker production. A procedure that I have found to work well is to collect single cuttings from 30 or more locations within a clone. Using this procedure I have found significant differences in suckering capacities among clones (Schier 1974).

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